Antireflective nanostructures replicated from black silicon

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Antireflective nanostructures replicated from black silicon

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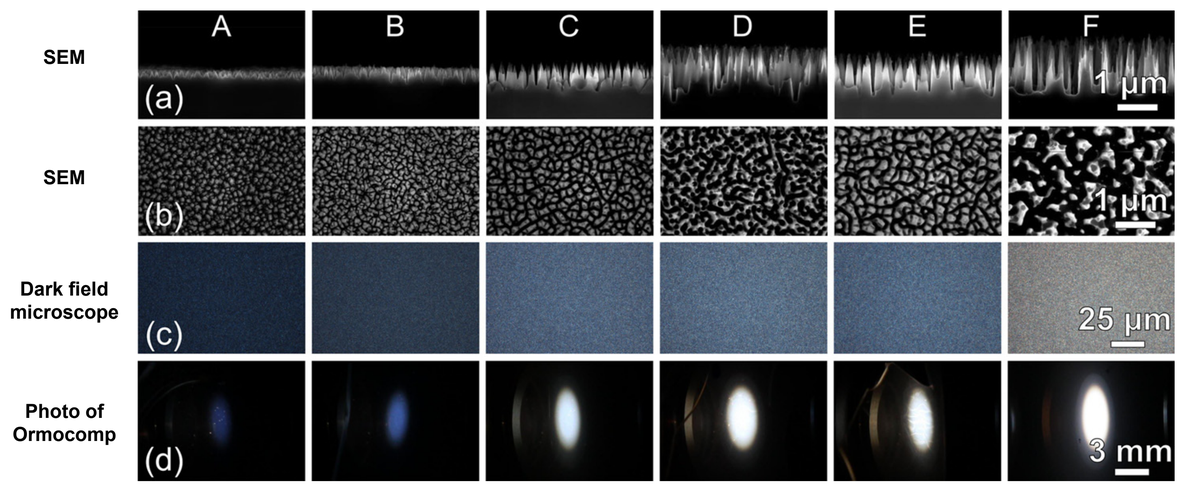
Introduction

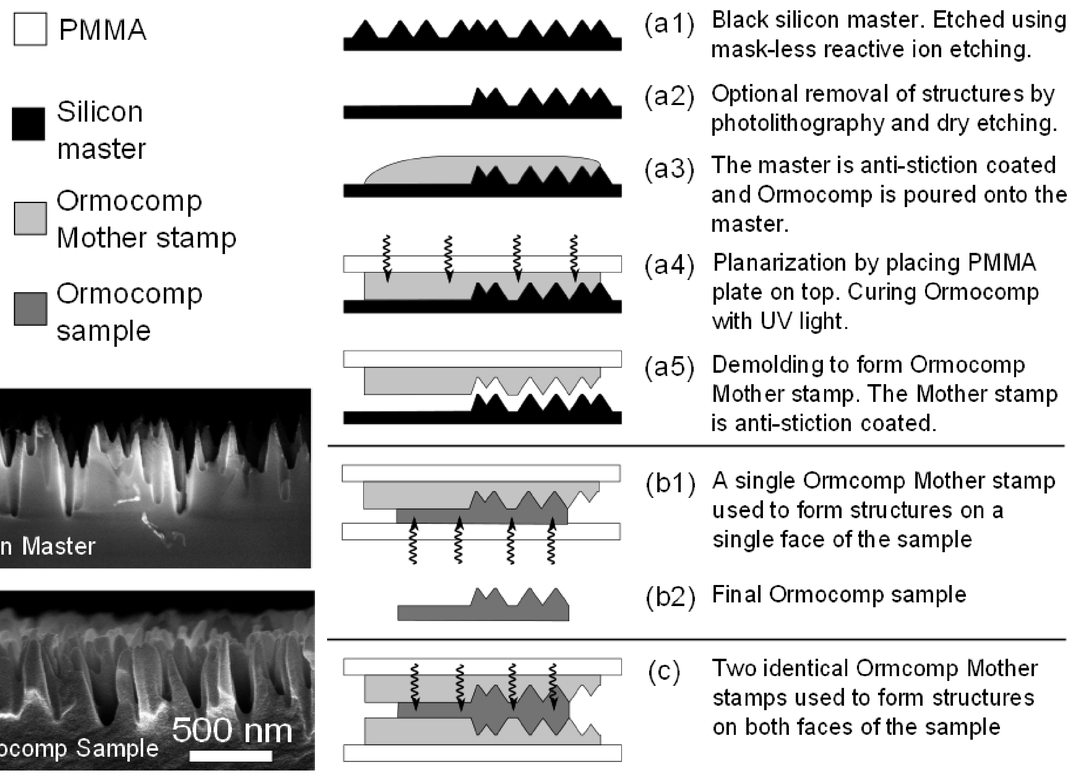
Can expensive multilayer antireflective coatings for e.g. glasses and camera objectives be replaced by cheap nanostructured surfaces? Can we use black silicon nanostructures to increase light transmission through a medium? Or will the light just be scattered on the randomly structured surface?

Black silicon and scattering properties

Different types of black silicon seen from side (a) and top (b). The realative scattering properties of the six surfaces can be estimated using dark field optical microscope images (c). Samples were illuminated by a intense white light source under normal incidence, and the scattered light was photographed at an oblique angle.

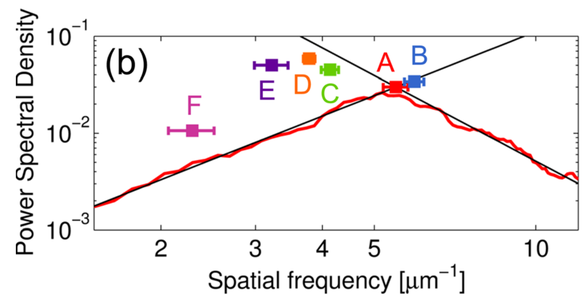


Fabrication



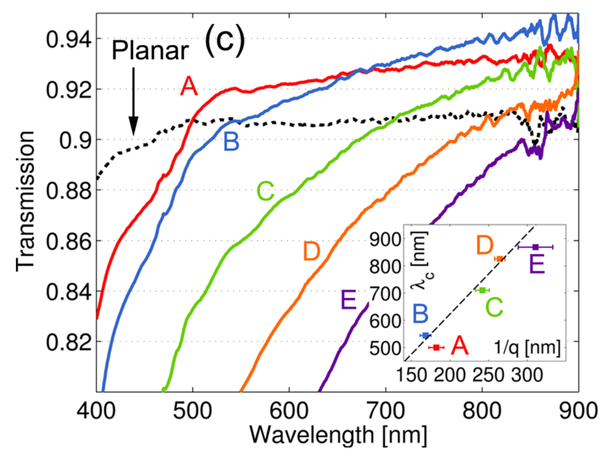
Spatial frequencies and transmission measurements

Power spectral density of SEM image of the black silicon surfaces reveal a dominating spatial frequency of the structures.



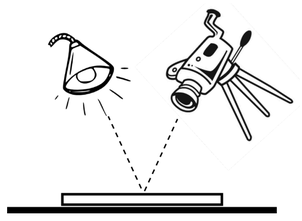
Measurements show that light transmission through the Ormocomp samples is increased for longer wavelengths. Light with low wavelength is scattered. more easily.

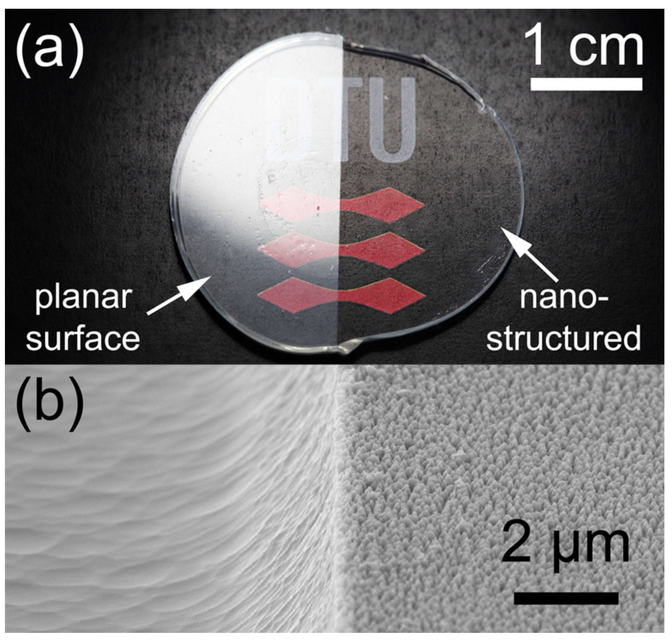
The cutoff at which transmission is increased is related to the spatial frequency of the nanostructures (see insert).



Prototype

Type A structures proved the most promising and are used for a prototype. With antireflective nanostrucutres on both faces of this Ormocomp sample, the effect is clear. The specular reflection of the lamp is reduced significantly, and the sample retains transparency.





Conclusion

Black silicon structures are replicated to Ormocomp films. Using Fourier analysis of SEM images of the surfaces we can determine the dominating spatial period of the surfaces. Light with short wavelength is scattered more on the random structures, and the wavelength cutoff for scattering of light is related to the period of the structures.

Type A black silicon structures with a period of 160 nm, a height of 200 nm, and aspect ratio of 1.3 show insignificant scattering of light with wavelength above 500 nm and lower the reflectance by a factor of two, for an Ormocomp surface.

Link to paper

Acknowledgments

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A. B. Christiansen, J. Clausen, N. A. Mortensen, A. Kristensen, Appl. Phys. Lett. **101**, 131902 (2012)